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Forest Health Protection

Pacific Southwest Region
Northeastern California Shared Service Area

Date: February 3, 2016
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To: District Ranger, Yuba River Ranger District, Tahoe National Forest

Subject: Evaluation of western pine beetle activity in ponderosa pine stands, Yuba River Ranger District, Tahoe National Forest (FHP Report NE16-02)

Report Summary

- Extreme drought conditions are putting additional stress on already overstocked and unhealthy ponderosa pine stands.
- Western pine beetle activity has increased dramatically in the past year and is now causing mortality in groups from 10 to 200 trees that are well distributed across the entire ponderosa pine belt of the Yuba River RD (Figure 1).
- Ponderosa pine mortality is expected to increase in 2016, and with continued drought, has the potential reach epidemic levels similar in intensity to the current outbreak in the southern Sierra Nevada forests (Appendix A).
- The District should be prepared for a worst case scenario that could strain resources in dealing with the removal of bark beetle-killed trees for public safety and the protection of critical infrastructure such as powerlines, roads, administrative sites and campgrounds.
- In the event of an outbreak, excessive ponderosa pine mortality could lead to a fuels build up that may take several years to mitigate.
- Suggested long-term management objectives for this area are to reduce stand density to reduce the risk of bark beetle-caused tree mortality, create defensible space adjacent to private land and communities, increase tree species diversity in plantations and maintain and enhance tree species diversity in native stands.

Figure 1. Native and plantation ponderosa pines attacked by western pine beetle and California fivespined ips, Yuba River RD.

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Background and Area Description

At the request of Eric Burke, District Timber Management Officer, Yuba River Ranger District, Danny Cluck, Forest Health Protection (FHP) Entomologist, visited lower elevation ponderosa pine stands from Downieville, CA south to Interstate 80 with district staff on December 16, 2015. The objectives of the visit were to determine the extent of western pine beetle-caused ponderosa pine mortality, evaluate current stand conditions and discuss treatment alternatives.

The ponderosa pine belt of the Yuba River RD exists within a limited range between lower elevation oak woodlands and higher elevation mixed conifer forests. Ponderosa pine dominated stands are found on south and west facing slopes, ridgetops and drier valley bottoms often mixed with black oak, incense cedar and Douglas-fir. Many pure ponderosa pine plantations also exist within this broad geographic area. Annual precipitation ranges from approximately 40 to 70 inches.

Western Pine Beetle Activity

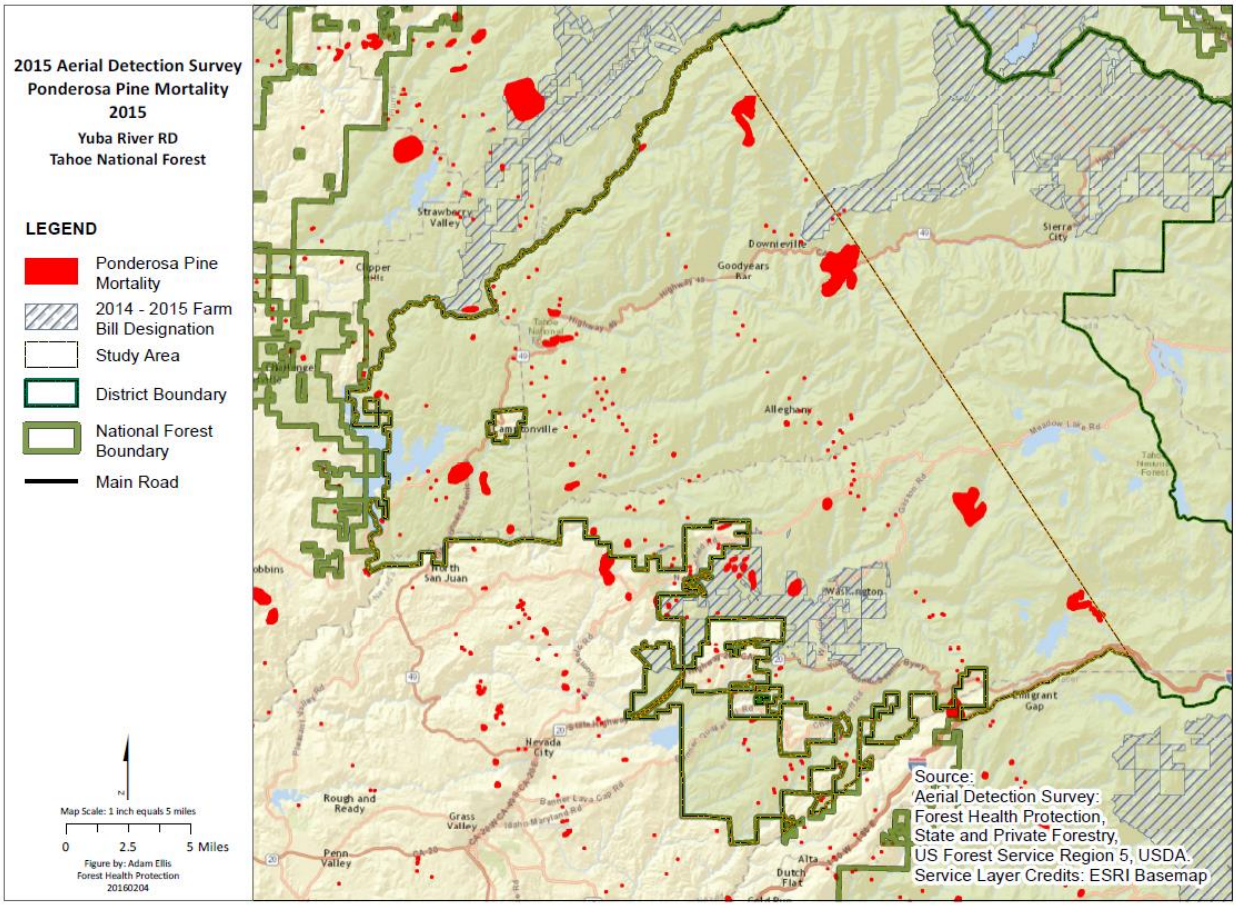
Western pine beetle (*Dendroctonus brevicomis*)-caused ponderosa pine mortality has increased dramatically within the past year throughout the entire ponderosa pine belt of the Yuba River RD and adjacent private land. Large groups of dead trees were observed all along the Highway 49 corridor (Figures 1 and 3) and along Highway 20 (Figure 2). Large numbers of ponderosa pines were also top-killed by California fivespined ips (*Ips paraconfusus*). These were mostly adjacent to recent large western pine beetle-killed groups.

Figure 2. Large western pine beetle-caused group kill of ponderosa pines in Bear Valley, Yuba River RD.

FHP aerial detection surveys mapped considerable ponderosa pine mortality in July 2015 (ADS July 13-17, 2015). Most of the observed mortality was in small groups but these were well distributed across the landscape (Figure 4). Altogether, the total number of dead ponderosa pines was estimated at 13,000 distributed across roughly 4,000 acres (~150 distinct groups) on USFS land (dead trees and acres were calculated from area within black and yellow line in Figure 4, named "Study Area"). Additional mortality was mapped on adjacent private land. Ground observations made in December 2015 revealed that the mortality mapped by ADS in July 2015 had increased dramatically with large patches (10 to 200 trees) of ponderosa pine mortality scattered across the entire area.

Figure 3. Dead and dying ponderosa pines on US Forest Service and private land near Camptonville, CA.

Figure 4. Mapped areas with ponderosa pine mortality, 2015 Aerial Detection Survey*



*Red polygons represent areas where tree mortality is occurring. They do not indicate that all trees are dead within a given polygon.

Stand Conditions

Most native ponderosa pine stands in this area in an overstocked condition with high numbers of large diameter trees (>20" dbh). Plot data from a representative native pine dominated area shows an average of 254 sq.ft./acre of basal area (range 161 – 387) and an average stand density index (SDI) of 491 (range 306 – 626). Stands in this condition are extremely susceptible to elevated mortality caused by western pine beetle and California fivespined ips, especially during periods of drought. Many plantations are also overstocked and at a high risk for bark beetle-caused mortality with slightly smaller trees (12-20" dbh). Plot data from representative pine plantations shows an average of 171 sq.ft./acre of basal area (range 161 – 175) and an average stand density index (SDI) of 297 (Deer Creek Project). On drier south and west facing slopes, ponderosa pines have encroached into areas of brush, black oak, and canyon live oak in the absence of fire. These tend to be poor sites for conifers and ponderosa pine mortality is high in these areas even at relatively low stand densities.

Discussion and Recommendations

The current stand density that exists within most areas is well above the limiting SDI of 365 for ponderosa pine. SDI 365 is considered the upper management zone for ponderosa pine above which bark beetle outbreaks are likely to occur (Oliver 1995).

High stand density combined with drought conditions cause extreme moisture stress in individual trees, thus reducing their ability to fend off bark beetle attacks. Healthy ponderosa pines defend themselves by producing resins that drown attacking beetles. When trees are stressed, resin pressure is reduced and the probability of successful bark beetle attack is increased. High stand density may also improve conditions for the bark beetle pheromone communication system, which facilitates mass attacks on individual trees, by concentrating the pheromone plume under a full canopy.

Long-term management

The best strategy to decrease the amount of mortality in the long-term is to reduce stand density through thinning (Appendix B). Thinning will increase the health and vigor of residual ponderosa pines by reducing competition for limited soil moisture (Fettig et al. 2007). The District should reduce the SDI in ponderosa pine dominated stands to below 230. SDI 230 is the defined threshold for the zone of imminent bark beetle caused mortality. Within this zone, endemic populations kill a few trees but net growth is still positive (Oliver 1995). Thinning stands to this level will reduce the risk of additional bark beetle-caused mortality by reducing tree competition for limited water and nutrients.

Dense ponderosa pine plantations would benefit by an overall reduction in stand density with an emphasis placed on maintaining and enhancing conditions for other species such as Douglas-fir, incense cedar and black oak. Thinning prescriptions should aim to reduce basal area to an average of 80 to 120 sq.ft./acre. This should effectively reduce the risk of significant western pine beetle-caused mortality.

Short-term management

Stand thinning can have immediate positive effects on reducing the level of bark beetle attacks on individual trees by opening up the canopy to disrupt the pheromone communication system. This creates convection currents and air turbulence through increases in soil temperature (Bartos and Amman 1989).

Although thinning can lead to immediate reductions in bark beetle attacks on individual trees due to changes in microclimate, treatments would have to cover large areas of high risk ponderosa pine forest to make a difference at the landscape level. It is unlikely that thinning treatments can be implemented at a suitable scale at this late stage of the drought to reduce the level of expected tree mortality over large areas, especially since many high risk stands are on private land. The District should therefore identify any critical areas for treatment with CE authorities to try to reduce the potential for excessive tree mortality at the local level. The success of these types of treatments will depend on the duration and intensity of the current drought. With intensifying

drought and the potential for a western pine beetle outbreak, small scale treatments may ultimately fail to significantly reduce tree mortality.

Efforts to reduce stand density through sanitation thinning in small strategic areas could be covered under the National Environmental Policy Act (NEPA) by Categorical Exclusion #14 [36 CFR 220.6(e)(14)] *Commercial and non-commercial sanitation harvest of trees to control insects or disease not to exceed 250 acres, requiring no more than ½ mile of temporary road construction, including removal of infested/infected trees and adjacent live uninfested/uninfected trees as determined necessary to control the spread of insects or disease*. It is my opinion that this type of project applied to high risk pine dominated stands that are within or adjacent to western pine beetle-caused mortality pockets on the Yuba River RD would meet the criteria outlined in this categorical exclusion.

At a minimum, the District should be prepared for a worst case outbreak scenario that could strain resources in dealing with the removal of bark beetle-killed trees for public safety and the protection of critical infrastructure such as powerlines, roads, administrative sites and campgrounds. Excessive ponderosa pine mortality may also require extensive fuels work over several years to create defensible space within the wildland urban interface.

Potential for FHP Funding

Forest Health Protection may be able to assist with funding for thinning and removing green material from overstocked areas. Thinning projects as described above would meet the minimum requirements for Western Bark Beetle Program funding and are supported by this evaluation. If you are interested in this competitive funding please contact me for assistance in developing and submitting a proposal.

If you have any questions regarding this report and/or need additional information please contact me at 530-252-6431.

/s/ Danny Cluck

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cc: Eric Burke, Timber Management Officer, YRRD
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Citations:

Bartos, D.L., Amman, G.D., 1989. Microclimate: an Alternative to Tree Vigor as a Basis for Mountain Pine Beetle Infestations. RP-INT-400. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT, 10 pp.

Fettig, C.J.; Klepzig, K.D.; Billings, R.F.; Munson, A.S.; Nebeker, T.E.; Negrón, J.F.; Nowak, J.T. 2007. The effectiveness of vegetation management practices for prevention and control of bark beetle outbreaks in coniferous forests of the western and southern United States. Forest Ecology and Management. 238: 24–53.

Oliver, W.W., 1995. Is self-thinning in ponderosa pine ruled by Dendroctonus bark beetles? In: Proceedings of the 1995 National Silviculture, Workshop, GTR-RM-267. U.S. Department of Agriculture, Forest Service, Rocky
Mountain Research Station, Fort Collins, C.O., pp., 213–218.

Western Pine Beetle

The western pine beetle, *Dendroctonus brevicomis*, has been intensively studied and has proven to be an important factor in the ecology and management of ponderosa pine throughout the range of this host species (Miller and Keen 1960). This insect breeds in the main bole of living ponderosa pine larger than about 8 inches dbh. Normally it breeds in trees weakened by drought, overstocking, root disease, dwarf mistletoe or fire. Adult beetles emerge and attack trees continuously from spring through fall. Depending on the latitude and elevation, there can be from one to four generations per year.

Evidence of Attack

Initial attacks are made about mid-bole and subsequent attacks fill in above and below. Pitch tubes are formed on the tree trunk around the entry holes. The pitch tubes are red-brown masses of resin and boring dust. Relatively few, widely scattered, white pitch tubes usually indicate that the attacks were not successful and that the tree should survive. Pheromones released during a successful attack attract other western pine beetles. Attacking beetles may spill over into nearby apparently healthy trees and overwhelm them by sheer numbers.

Life Stages and Development

These beetles pass through the egg, larval, pupal and adult stages during a life-cycle that varies in length dependent primarily upon temperature. Adults bore a sinuous gallery pattern in the phloem and the female lays eggs in niches along the sides of the gallery. The larvae are small white grubs that first feed in the phloem and then mine into the middle bark where they complete most of their development. Bluestain fungi, introduced during successful attacks, contribute to the rapid tree mortality associated with bark beetle attacks.

Conditions Affecting Outbreaks

Outbreaks of western pine beetle have been observed, and surveys made, in pine regions of the West since 1899 (Hopkins 1899; cited in Miller and Keen 1960). An insect survey completed in 1917 in northern California indicated that over 25 million board feet of pine timber had been killed by bark beetles. Information from surveys initiated in the 1930s indicates that there were enormous losses attributed to western pine beetle around that time. During the 1930's outbreak, most of the mortality occurred in stands of mature or overmature trees of poor vigor (Miller and Keen 1960). Group kills do not typically continue to increase in size through successive beetle generations as is typical with Jeffrey pine beetle. Rather, observations indicate that emerging beetles tend to leave the group kill area to initiate new attacks elsewhere.

The availability of suitable host material is a key condition influencing western pine beetle outbreaks. In northeastern California, drought stress may be the key condition influencing outbreaks. When healthy trees undergo a sudden and severe moisture stress populations of western pine beetle are likely to increase. Healthy trees ordinarily produce abundant amounts of resin, which pitch out attacking beetles, but when deprived of moisture, stressed trees cannot produce sufficient resin flow to resist attack. Any condition that results in excessive demand for moisture, such as tree crowding, competing vegetation or protracted drought periods; or any condition that reduces that ability of the roots to supply water to the tree, such as mechanical damage, root disease, or soil compaction, can cause moisture stress and increase susceptibility to attack by the western pine beetle. Woodpeckers and predaceous beetles are natural control agents when beetle populations are low.

Appendix A

USDA

News Release

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Tree Mortality in the Sierra National Forest

CLOVIS, Calif., December 14, 2015 – Following four years of drought, forests throughout the Southern Sierras are experiencing a tree mortality event at a scale unprecedented in recorded history. Locals and visitors to the Sierra National Forest (SNF) are well aware of this event, as dead trees are visible in staggering numbers throughout the landscape. Beyond the direct effects of the drought itself, tree mortality has greatly increased as a result of the infestation by the western pine bark beetle. Though the beetle is native to this area, stress on trees from the drought has left them with weakened defenses, resulting in even higher mortality rates.

The SNF has been tracking the progress of this event since 2014, conducting ground and aerial surveys to better understand the extent of tree mortality and to help predict future spread. With our latest flight detection, it is estimated that 350,000 acres of Forest are affected, and that between the elevations of 3,000 and 6,500 feet, tree mortality rates are between 50-60%, with localized mortality even higher. With resources available and a primary focus on public safety, the SNF has been prioritizing a response to this event. Beginning in the summer of 2015 the Forest has been working with partners to fell and remove dead trees from campgrounds, recreation, permitted, and administrative facilities, and along our most developed roads. In light of the increased fuel load created with so many dead trees, fire suppression managers have been evaluating community defense plans. The Forest continues to seek additional support and capacity to address tree mortality; and this issue has become a Regional priority, with the SNF identified as the "epicenter" for these compounded effects. Working with State, County, local, industry and public partners to address these issues, it should be expected that these efforts will continue for several years.

There are several things you can do to increase your personal safety when in the Forest. Remember to look up at the trees that are around you; if the tree is brown or red it is likely dead and is likely not a safe place. Keep an eye out for a lot of red pine needles on the ground, which can indicate nearby dead trees. React to the things that you see and hear; if there is a loud crack or split, leave the area as limbs may be falling. Make sure that you do not pitch your tent or park your car under dead or dying trees. Remember that dead trees and limbs are more likely to fall during wind events, so drive and recreate with caution.

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Experimental research on thinning and bark beetle-caused mortality in ponderosa pine and white fir forests

Location	Reps	Time Period	Thinned Density (Tree Mortality) vs Non-Thinned Density units (Tree Mortality units)	Study Findings	Literature cited
			Studies in Ponderosa Pine Forests		
Northeast CA - Warner Mnts	1	1961-1965	23 (13-26 or 4-12%) vs 64 m^2/ha (542 trees/0.4 ha or 38%) [a]	Thinned plot less conifer mortality; vigor and microclimate both appear as mechanisms	Hall and Davies 1968
Northeast OR - Sumpter Valley	1	1967-1972	3.5 (.75), 4.5 (.06), 5.5 (.00), 6.5 (.00) vs no spacing m (2.7 m^2/ha BA) [b]	Thinning reduced conifer mortality; thinning + direct control no different than thinning alone	Sartwell and Dolph 1976
Black Hills, SD - Black Hills NF	1	1979-1980	10 (0), 17 (0), 20 (3.5) vs 45 m^2/ha BA (14 trees/ha/year), 42 (28), 46 (17) [c]	Thinning reduced conifer mortality in case study	McCambridge and Stevens 1982
Northeast CA - Lassen NF	3	1980-1994	18 (0.0), 23 (0.0), 32 (0.5) vs 44 m^2/ha BA (6.0 trees/ha/year)	Thinning reduced conifer mortality	Fiddler et al. 1989
Black Hills, SD - Black Hills NF	1	1986-1989	14 (<1), 18 (<1), 23 (.66) vs. 29 m^2/ha BA (3% BA) [d e]	Thinning reduced conifer mortality in case study - BA threshold around 28 m^2/ha BA	Schmid and Mata 1992
Northeast OR - Blue Mnts	3	1959-1989	2.7, 3.1, 3.8, 5.2 (m spacing) vs no spacing	82% of mortality in >200 SDI; thinning reduced the density of mortality at alpha=.10	Cochran and Barrett 1993
Northeast CA - Warner Mnts	1	1959-1995	25, 50, 128 vs 157 SDI	Mortality threshold for NE CA at 230 SDI; self-thinning ruled by *Dendroctonus* in NE CA	Oliver 1972 & Oliver 1995
North CA - Eliott Ranch	3	1970-1995	73,128,183, 238 vs 293 SDI [f]	Mortality threshold for NE CA low productivity sites at 183 SDI or BA >23 m2/ha	Oliver 1997
North WA - Methow Valley	3	1958-1988	4, 5.7, 8.0 vs 1.3 m spacing [g]	Majority of mortality SDI >250; mortality switched from suppression to MPB-caused at 17.8 cm QMD	Cochran and Barrett 1998
Black Hills, SD - Black Hills NF	1	1986-2004	14 (9), 18 (53), 23 (48) vs 35 m^2/ha GSL (77%) [e]	Thinning plots surrounded by unmanaged forest may not reduce stand susceptibility to mortality	Schmid and Mata 2005
			Studies in White Fir Forests		
Central OR - Freemont NF	3	1991-1995	112 (7-27), 168 (14-46), 224 (24-63), 280 SDI (19-79% trees/ha) [h]	Density and percent mortality positively related to host density; thinned plots all had mortality	Cochran 1998

[a] Density (trees ha^{-1} killed) mortality and percent mortality (trees ha^{-1} killed / trees ha^{-1} of available host) for the 3 thinned plots presented as ranges; percent mortality calculated by dividing density of mortality from 1 non-thinned plot by estimate of available density of host from data taken on 19 variable radius plots of surrounding unmanaged forest

[b] designed for 2 but 1 was accidentally logged and destroyed for research purposes

[c] Case study data shown for each thinned then each respective non-thinned paired plot where mortality data averaged for the 2 years sampled

[d] Percent mortality is average of 3 years sampled [e] 10 reps in experiment - 1 reported in this study [f] Thinning first occurred with GSL targets then SDI targets over course of experiment

[g] Study did not indicate mortality levels for each spacing treatment

[h] Range of percent mortality results reported from three Freemont NF blocks that experienced fir engraver-caused mortality; all plots thinned in this experiment

Literature Cited

Cochran, P. H., Barrett, J. W., 1993. Long-Term Response of Planted Ponderosa Pine to Thinning in Oregon's Blue Mountains. Western journal of applied forestry. 8(4), 126-132.

Cochran, P. H., Barrett, J. W., 1998. Thirty-Five-Year Growth of Thinned and Unthinned Ponderosa Pine in the Methow Valley of Northern Washington. RP-PNW-502. USDA, Forest Service, Pacific Northwest Research Station, Portland, OR, 24 pp.

Cochran, P. H., 1998. Examples of Mortality and Reduced Annual Increments of White Fir Induced by Drought, Insects, and Disease at Different Stand Densities RN-PNW-525. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR, 19 pp.

Fiddler, G. O., Hart, D. R., Fiddler, T. A., McDonald, P. M., 1989. Thinning Decreases Mortality and Increases Growth of Ponderosa Pine in Northeastern California. RP-PSW-194. USDA, Forest Service, PSW, Berkeley, CA, 7 pp.

Hall, R. C., Davies, G. R., 1968. Mountain Pine Beetle Epidemic at Joseph Creek Basin Modoc National Forest. Division of Timber Management, USDA Forest Service, San Francisco, CA. 22.

McCambridge, W. F., Stevens, R. E., 1982. Effectiveness of Thinning Ponderosa Pine Stands in Reducing Mountain Pine Beetle-Caused Tree Losses in the Black Hills--Preliminary Observations. RN-RM-414. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO, 3 pp.

Oliver, W. W., 1972. Growth after Thinning Ponderosa and Jeffrey Pine Pole Stands in Northeastern California. RP-PSW-85. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Berkeley, CA, 8 pp.

Oliver, W. W., 1995. Is Self-Thinning in Ponderosa Pine Ruled by Dendroctonus Bark Beetles? In National Silviculture Workshop Forest Health through Silviculture: Proceedings of the 1995 National Silviculture Workshop, Mescalero, New Mexico, May 8-11, 1995 (pp. 213-218): Fort Collins, Colo. : USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

Oliver, W. W., 1997. Twenty-Five-Year Growth and Mortality of Planted Ponderosa Pine Repeatedly Thinned to Different Stand Densities in Northern California. Western journal of applied forestry. 12(4), 122-130.

Sartwell, C., Dolph, R. E., Jr., 1976. Silvicultural and Direct Control of Mountain Pine Beetle in Second-Growth Ponderosa Pine. RN-PNW-268. USDA, Forest Service, Pacific Northwest Research Station, Portland, OR, 8 pp.

Schmid, J. M., Mata, S. A., 1992. Stand Density and Mountain Pine Beetle-Caused Tree Mortality in Ponderosa Pine Stands. RN-RM-515. USDA, Forest Service, Rocky Mountain Research Station, Fort Collins, CO, 4 pp.